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DESCRIPTION

OF THE

NEW PATENT INSTRUMENT

FOR

EXTRACTING TEETH;

ALSO OF

A Patent Method

OF

FIXING ARTIFICIAL TEETH.

BY

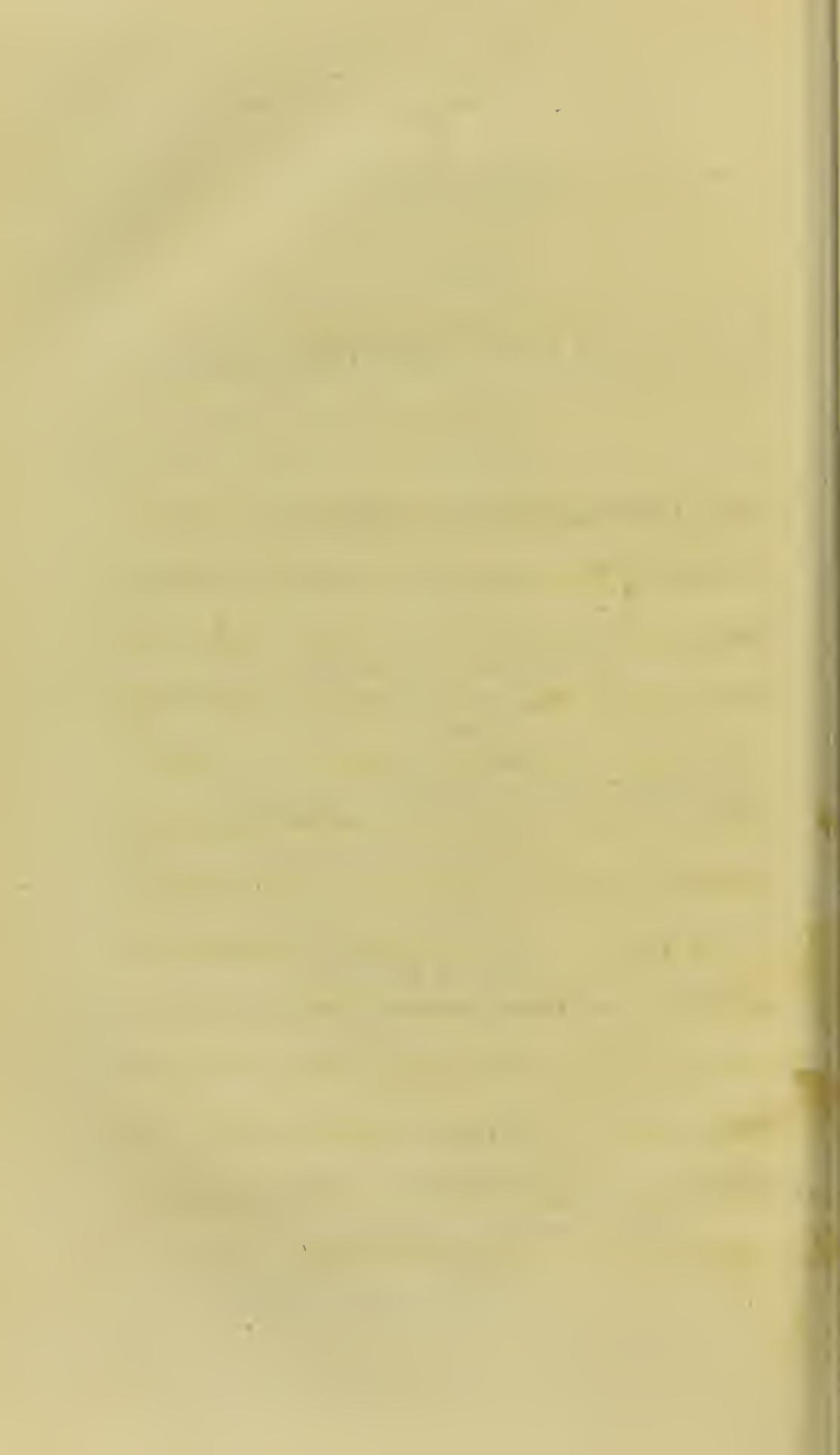
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M.DCCC.XXVI.



P R E F A C E.

HAVING recently obtained a double Patent for a newly-invented Instrument for extracting teeth, and also for a new and very superior method of fixing artificial teeth, I shall, after a few prefatory observations, submit to the Public, in this tract, as concise a description as possible of the two Inventions above named, being fully persuaded that a simple statement of the subject will be sufficient to ensure a very extended approbation and patronage.

The reader will please to observe, that my object in the present publication is simply to give a description of the new Instrument and method before mentioned, the accompanying observations upon the teeth, &c. being merely cursory, and introduced for the purpose of illustration: I may probably, at some future period, publish a **NATURAL HISTORY OF THE TEETH**, in which case, the subject will necessarily come before the Public in a complete form.

At the time of soliciting a Patent, it was my intention to enter more fully into the nature of the invention, by giving a considerable number of cases, with the methods of ope-

rating adapted to each ; but finding the requisite time for the drawings too great for my daily avocations, I was obliged (every Patentee being limited to a certain time for entering his specification) to rest satisfied with including just so much of my contrivance as would secure it against legal quibbles.

Although he who improves upon an art ought, in justice, to reap the fruit of his own labours, my motives in taking out a Patent were not solely to secure to myself an exclusive right; (the preference usually given to the contriver of any new invention, which depends for success upon its judicious application, being

quite a sufficient guarantee;) I have taken this step to prevent those who, under pretence of adopting my methods, might, by ill-contrived imitations, bring them and their inventor into disrepute.

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PART I.

A

DESCRIPTION

OF THE

NEW PATENT INSTRUMENT

FOR

EXTRACTING TEETH.



A

DESCRIPTION,

&c. &c.

ONE of the most obvious ideas arising in the mind, in the consideration of any practical science, is, the very tardy process by which it has arrived at any thing like perfection. This observation, strange as it may appear, is capable of being applied, in the strongest manner, to those sciences, the practice of which has been of the most frequent occurrence, such as ANATOMY and PATHOLOGY. It would be not less instructing than curious to attempt to trace these two sciences to their origin among the ancients. All, however, I intend at present is, to make a few general observations on the subject.

The Chaldeans, we know, transmitted to the Egyptians the art of embalming dead bodies, which the latter so successfully practised;* but what more do we know of any thing among the Chaldeans, which had even an *approximation* to either of the above sciences than this? If we come to Egypt itself,—a country celebrated for learning and science,—the nurse, or rather the mother, of Grecian greatness, we shall be equally disappointed. And here we cannot but lament that, while great pains have been taken to perpetuate and emblazon the achievements of their kings, some of the skill possessed by the nations

* The art of embalming dead bodies originated in the belief of the return of the soul to its old tenement, after a considerable lapse of years. Bodies embalmed, (or mummies, as they are termed,) have been kept in a good state of preservation for upwards of two thousand years. In the breast of one of these mummies a branch of rosemary was found, scarcely dried.

of antiquity for transmitting events to posterity should not have been employed, less ostentatiously indeed, but not less usefully, in furnishing us with some particulars of their physiological experience. An account of the method of curing a fever, dressing a wound, or even extracting a tooth, as practised by the Egyptians, would be now read, probably, with greater interest than the recital of the exploits of Sesostris himself.

The writings of the Greek and Roman physicians, though in many things correct, prove the mistiness of their knowledge upon the subject of their profession. Like the other writers of antiquity, in every thing but plain *matter of fact* cases, we are often amused by their imaginative fecundity, and their philosophical *wordiness*, but left in a great measure uninstructed as to the topic of discussion. In the rude state of society, or rather the simplicity of manners, which

existed about the time of the siege of Troy, when Ulysses manufactured his own bedstead, we are not disappointed at finding the prescriptions in Homer depending, in a great measure, for their success upon the agency of their tutelary deities; but in Rome, and that in a late period of her history, we hear, with surprise, that the practice of medicine should have been almost entirely in the hands of slaves. The fact of the immense loss of the wounded after a battle is a sufficient proof of the ignorance of the ancients of Anatomy.*

The superstition of the ancients may

* It is said, that Democritus, a philosopher of Abdera, while dissecting a brute, was surprised in the act by Hippocrates, who expressed himself greatly astonished that his friend could be guilty of so base an action, as it was considered nothing less than a contempt of the works of the Deity. Hippocrates added, that it was fortunate no other person witnessed his impiety. This is said to be the first dissection on record.

account for the slow progress of anatomical knowledge among them ; and the semi-barbarous state of the Romans, produced by their military propensity, must have given a fatal check to the *professional* cultivation of those sciences most closely allied to a state of peace.

To the ages which succeeded the destruction of the celebrated nations of antiquity, we are not to look for any improvements ; for the early history of Europe, after this period, was not at all calculated to bring to perfection any *germs* of science which might have been started into life by the ancients. St. Augustine, Tertullian, and Pope Boniface opposed vehemently the study of anatomy. The Emperor Charles the Fifth ordered a consultation of divines, to obtain their answer to the following query : “ Is it lawful, in point of conscience, to dissect dead bodies ? ” And we know

that, till lately, in Russia, the study of Anatomy and the use of skeletons were forbidden by law. Notwithstanding these obstacles, we must still look with surprise upon the slow progress of the sciences of which we have been speaking—sciences, the importance and interesting nature of which, it seems natural to suppose, would have excited the ancients, who had *souls* for every thing great, to have discovered and recorded so much, that a complete system of Anatomy, and its kindred sciences, should have been transmitted to posterity with the other memorials of their greatness. If we look to the records of ancient times for information upon the particular science treated of in this pamphlet, we shall find ourselves still more in the dark. The *dolor dentium*, the distressing pain called the tooth-ache, must have been common in all ages, and among all nations; and,

reasoning by analogy, which is all we can do in the present case, we must conclude, that if the teeth were artificially extracted, it must have been by the common forceps.* I have made these cursory observations for the simple purpose of disarming that prejudice which too frequently opposes scientific improvements as dangerous innovations. It has ever been the case, that nations have considered each of the successive ages, while it was passing, as the age of the *ne plus ultra* of science. Thus, to turn to our own country, where so much facility has been given to liberal studies, what a delay has prejudice alone created

* The art of tooth-drawing, according to Cicero, was invented by Esculapius, in whose temple the ancients suspended a leaden forceps. This was to show, that no teeth were to be extracted but such as were sufficiently loose to yield to a leaden instrument. But this was the *leaden* age of the experimental sciences!

in the progress of the science of medicine ! Let us just glance at the first introduction of what have not been inaptly termed the “ five Herculean remedies,” viz. Bark, Opium, Steel, Mercury, and Antimony. What opposition was made, by the Profession, to the introduction of bark into the practice of physic ! The same feeling of distrust, somewhat modified perhaps, was manifested in reference to the other, now popular, medicines. What was the consequence ? Private individuals applied these remedies so successfully, that their reputation became completely established, and the leading members of the profession were thus compelled to sacrifice their prejudices at the shrine of what may justly be termed, the evidence of a rational experience. Thus, by degrees, and by very slow degrees, do sciences advance ; and that, after they have been considered by the

respective professors, of every age, incapable of farther improvement.

I shall now proceed to offer a few observations upon the subject of this pamphlet, and then describe the instrument which I have invented for the delicate and difficult operation of extracting teeth;— an instrument the invention and use of which, I think I may say, without ostentation, will be considered as commencing a new era of improvement in this particular branch of science. It would be useless to dilate upon the importance of the proper management of the teeth, both for utility and appearance. Yet as this management is very generally neglected, through inconsideration or ignorance, till great injuries have been sustained, it appears to me essential, on the present occasion, to offer a few remarks upon this point.

A complete set of teeth consists of

thirty-two. These are distinguished after the following order,

In each adult jaw there are,

Two central *Incisores* :

Two lateral ditto :

Two *Cuspidati*, called also *Canini*, or dog-teeth :

Four *Bi-cuspides* :

Six *Molares*, or grinders.

The appearances and names of the several teeth are not more different than the uses to which they are applied; and, as might have been expected, the roots of the teeth differ from each other as much as the external parts of the teeth themselves. I make this remark here, because it will serve to illustrate the observations which I have made, in the succeeding paragraph, concerning the necessity, on the part of the operator, both in extracting and fixing teeth, of understanding

and attending to the formation of their roots,—a circumstance which is entirely disregarded by so many practitioners. This is absolutely essential, if we would operate with safety and success.

The teeth are real bones, set in sockets called *Alveoli*. The part of the tooth contained in the socket is the root, which in some of the teeth is single-fanged, as in the *Incisores*, *Canini*, and *Bi-cuspides*. In others, the root is double, triple, and even quadruple-fanged, as in the *Molares* or grinders. Hence we perceive the vast importance, in operating, of an accurate acquaintance with the roots of the teeth, and of using an instrument adapted to their particular formation. Want of attention to this circumstance is the cause of so many protracted, painful, injurious, and unsuccessful operations. I leave this point now, as I shall speak of it more

particularly when I come to describe my new-invented patent Instrument for extracting teeth. It will then be seen, that the difficulties attending the operation with other instruments are by this completely obviated.

The body, or upper part of the tooth, is covered with a hard, white substance, called enamel. Into this part of the tooth an artery, vein, and nerve are conveyed, through the extremity of the root. By these the teeth are nourished and rendered sensitive. Hence we find that a carious tooth must perpetually expose the patient to the most severe suffering. An avenue by a caries, being once opened to the seat of so much sensation, we need not be surprised that every other remedy, but that of extracting the tooth, should be of but temporary benefit. I may observe, however, that if the decay be detected in the

commencement, before it have penetrated to the sensitive part, stopping the teeth with gold, or any suitable metallic preparation, is a security for their future preservation.

The teeth are given for (1,) the purposes of mastication ; (2,) to assist articulation ; and (3,) to improve the appearance of the face.

The first of these points, which is the most important, is too seldom considered. Upon the proper mastication, or breaking of the food by the teeth, a good digestion of the food depends. In fact, I may assert, that a good digestion depends as much upon a good mastication, as good health upon a good digestion.

Many persons, heedless of the consequences, allow a carious tooth to remain till they are either tortured almost to madness, or absolutely driven to submit to

an operation, by the fear of losing the whole set. To say nothing of the tainted effluvia arising from a decay of the tooth, and the consequent offensiveness of the breath, were the indigestions, and their train of ill effects, produced by an imperfect mastication of the food, considered, scarcely any thing, one should suppose, would suffer an obstacle to be thrown in the way of extracting a tooth which has lost its character of utility and beauty, and assumed that of danger and deformity. As this is a case of very great importance, I shall make a few observations upon it, which will, I trust, make the subject both plain and useful. It ought to be familiar to every one who regards his health.

Digestion, which is the change of the aliments into chyle, for the purposes of nutrition, is performed by (1,) *mastication*; (2,) *deglutition*; (3,) *the action of the*

stomach and the gastric juice ; (4,) the mixture of the aliments with the bile and pancreatic juice ; and (5,) by the action of the intestines.

Now as it happens that the teeth are *directly* concerned with the first of these operations, it is obvious that they must, by their perfect or imperfect action, produce a corresponding effect upon every part of the subsequent process of digestion.

In different parts of the mouth are large quantities of saliva, issuing from the excretory ducts of the salival glands. This fluid is for the purpose of softening, by duly mixing with the food. Here it is that we see the importance of having the food properly masticated ; for unless this be done, how is the saliva to be mixed with it ? or rather, how are the saliva and food to be amalgamated ? There is as much difference between a perfect and imperfect

mastication of the food, with regard to the salival mixture, as there is between the absorption of water by a testaceous powder and by the rigid claw of a crab. If therefore this preliminary part of digestion—mastication, be not duly performed, how can we expect the subsequent parts to be duly performed? This cannot be done, unless indeed we suppose one part of the animal economy to be competent to assume the function of another part; as, for example, the stomach to perform both its own office and that of the teeth; a conclusion upon which no one will venture, who regards either experience or that prime law of nature in the body of man, by which every one of its multitudinous and mysterious parts is nicely adapted to its own respective office.*

* The following observations may serve to give a familiar illustration of this point:—The gastric juice

Let us now, passing over the intermediate passage, look at the partially concocted aliment in the stomach. How we start at the idea of swallowing any hard substance, or even of swallowing the food whole. What obstructions, inflammations, and dangers do we not anticipate if the event take place ! Yet this is always done to a certain

(the fluid by which the process of digestion is carried on in the stomach) of an owl, falcon, or kite, will not work upon grain, not even to finish the half-digested pulse which is left in the crops of the sparrows which these birds devour. In poultry, the trituration of the gizzard and the gastric juice unite in the work of digestion. The gastric juice will not dissolve the grain whilst it is whole ; but if the grain be broken or ground, this juice immediately lays hold of it. Here we perceive the gizzard performing the office of teeth, and the importance of attending to this adaptation of parts in the animal economy for the purpose of executing its functions. Hence we see the impropriety of keeping birds without sand or gravel, which they use for the purpose of comminuting their food by the muscular action of the two halves of the gizzard against each other.

extent, and to serious injury, by those whose imperfect mastication forces upon the stomach a task which it was never intended, and is altogether unable to perform. Indigestion must necessarily arise from this cause, though seldom suspected ; and as the aliment proceeds onwards to the formation of the chyle, how deficient in nutritive, and how impregnated with injurious qualities it must be, when received into the blood thus prepared, it is needless to point out.

Upon this point I shall close what I have to say, with the pertinent observations of an eminent physician of the last century : “ As digestion depends in part on the due preparation of the aliments, it is necessary to chew them well, especially if they are hard, that they may be more intimately mixed with the saliva ; for those who eat in a hurry, without much chewing, are very subject to indigestion. For this

reason infants should have little solid aliment, and old persons, and those who have lost their teeth; for mastication is of excellent use to promote digestion."

It will be seen, I hope, by these observations, how very extensive and important are the functions of the teeth in the animal economy. Indeed when a carious tooth is extracted, it is worth remembering, that the loss of the tormenting pain, which was the only motive of the patient in submitting to an operation, is but a very small part of the benefit which must accrue. A carious tooth always exposes the adjacent parts, to a considerable extent, to dangerous inflammation,* and the avoiding this liability—the preservation of the remaining teeth in a sound state—

* A case recently occurred, in which a young lady, having taken cold, was tortured with excruciating pain in one of the *molares*, which had gone to a state

and the benefit of perfect mastication, through affording an opening for the insertion of a good tooth, by the extracting of a bad one, are benefits which ought to induce an attention to the subject by the patient, and which should also be considered as rendering the time, skill, and experience of the operator well employed in endeavouring to make both these operations as easy, safe, and efficacious as possible. For these reasons, I have offered what observations appeared to me best suited

of considerable decay. She was compelled, as the only resource, to seek for relief in submitting to an operation. The neighbouring parts of the tooth, however, had become so inflamed, that the operation was considered too dangerous to be hazarded. In the course of two or three days, most alarming symptoms ensued. The inflammation extended to the tonsillary glands, afterwards to the mucous membrane of the fauces. A consultation of physicians was summoned, whose united efforts were scarcely sufficient to prevent the consequences of a rapidly approaching suffocation.

to place a subject of no small importance in its true light.

I shall say nothing here of the use of the teeth in articulation, and for the general improvement of the appearance of the face, as I shall have occasion to notice these points in the second part, where I shall introduce the subject of fixing artificial teeth.

I shall now commence my observations upon the different instruments in use for the purpose of extracting teeth, beginning with the Paces.

I shall then proceed to the description of my patent Forceps for extracting teeth,—an Instrument the use of which, I am persuaded, will obviate the principal objections which have hitherto prevailed, on the part of many, to submit to the operation of extracting a tooth.

On the Paces.

The instrument for extracting teeth, which would most naturally occur to the mind of the inexperienced, and those who are unacquainted with mechanics, and with the structure of the teeth, is the Paces, which is no other than the common pincers, simply altered in the form of the jaws, to ensure as firm a hold as possible, as well as to clear the crown of the tooth.* Although

* They are usually made with the internal part of the claws toothed or roughed in the manner of a rasp. This, however, is quite a useless practice, as no part of them should ever come into contact with the tooth, except the points. To be well made, the handles should have a degree of elasticity, to prevent the consequences of too tight a grasp on the part of the operator; as the tooth, in such a case, must inevitably break, unless the handles yield. The instruments lately introduced are very faulty, in being made much too strong; for it is far better that an instrument should break when improperly fixed, than that the tooth should be broken, and the injury transferred to the jaw-bone.

this instrument is extremely useful in removing single-fanged teeth, or roots which are loose in their sockets, it is highly objectionable in extracting the *molares*, or large double teeth, which hold so firmly by reason of their diverging, crooked, or otherwise mis-shapen roots, that the most powerful exertions and repeated endeavours to loosen them by such means would prove ineffectual. Fortunate indeed, in such a case, would the miserable sufferer be, were he to escape such a species of inquisition without the crown of the tooth breaking, and leaving a still more painful operation to be performed, viz., that of punching out (as it is termed) the two or more remaining stumps, by way of concluding the torture.

In cases where the crown of the tooth is very much decayed, the Paces cannot possibly be used with success, as the pinch requisite to prevent their slipping, in en-

deavouring to loosen it, is greater than the remaining substance of the tooth is capable of supporting. Even the most scientific and judicious operator cannot possibly guard against breaking a tooth, when it is sometimes so brittle, as well as hollowed out with decay, as to be incapable of sustaining the force necessary to extract it with a far better instrument.

For extracting the *molares* of the lower jaw, the Paces, under any form, are still more objectionable, by reason of the lower teeth inclining so much inwards. If the straight Paces be used, no perpendicular force can be obtained, and the lateral action will be unavoidably much greater than is necessary in using the Key.

The bent Paces, which are curved at the ends, so as to act at right angles with the handles, are equally improper, as the operator must apply so much additional

force, having, as it were, to raise a great weight at the end of a lever, that, if he have power to remove it, it so suddenly yields, that the instrument, flying upwards with a jerk, often either fractures or loosens one of the opposite teeth, which circumstance the operator can no more control than he could avoid falling, if he were drawing an immense weight, and the cord were suddenly, though not unexpectedly, to break.

Another disadvantage is the length of time requisite for the loosening of a tooth with the Paces, which can only be done by working them to and fro from side to side; for lateral action in this, as in all other instruments, is indispensable, since the crown would break off before a strong tooth would yield to a dead pull.

These observations will be sufficient in reference to the Paces; I shall now introduce the Key Instrument.

The Key Instrument.

The Key differs greatly in its structure from the Paces, being composed of a stem, having an oval-shaped piece of steel at one end, called a bolster, (see Plate I, fig. 5, A,) which bolster takes its bearing partly on or against the neck of the tooth to be extracted, or sometimes on the adjoining one, as may be judged most expedient by the operator. To the upper side of the bolster is attached a circular piece of steel playing freely upon a screw, passing through a hole at one end, and terminating in the form of a claw at the other, for the purpose of laying hold of the neck of the tooth. This it does by turning the stem on its axis, by means of a handle fixed at right angles on the end opposite the bolster, which, if skilfully adjusted, will remove the tooth with very great facility. Some un-

founded objections have been made to this instrument, by those who, by their *mechanical* knowledge, may comprehend its application perfectly, but, for want of experience, are not sufficiently acquainted with the form of the teeth at their roots, as well as of the structure of the bones supporting them, to be competent judges. Preparatory to explaining the uses of this instrument, and its decided superiority over the Pincers, it will be necessary to shew the usual form of the roots of the teeth; and having done this, it will be seen, with the assistance of the diagrams, that at the moment it receives its impulse, by turning the handle, it acts in the best possible direction for loosening and raising the tooth; that is, supposing a proper-sized claw to have been selected, and the bolster rightly fixed. And were it not that, after it is so loosened, the point of the claw

is rapidly deviating from the perpendicular, the use of the Paces would not be required, as it frequently is, when the tooth hangs in the socket.

It can no more be expected that one instrument should answer for every tooth to be extracted, than that one remedy should be effectual in eradicating every disease. This will be evident, when we consider that the sixteen pair of teeth, which compose a perfect set, all differ, more or less, in the position, form, and number of their roots; and in addition to this, that each of those roots are liable to considerable deviation from their natural form. Operations often fail, in consequence of affixing the bolster on the wrong side of the tooth, some teeth requiring to be extracted towards the outside, and others inwardly; but for this, no established rule can possibly be laid down, as it depends

entirely on the skill of the operator, and is frequently governed by the state of the decay.

Having said thus much of the Key Instrument, I proceed to the illustration and proof, by reference to the Plate.

Plate I, fig. 1, 2, 4, 5 represent the usual form of the fangs of a lower *molare*. From this, it is evident, that in extracting the lower tooth in a perpendicular direction, as represented by the dotted line passing through its axis, (see Plate I, fig. 2, at C,) the operation would not be performed more easily, than if it were taken in the direction D: this may be better elucidated by proposing an extreme case.

Suppose one cone inserted in another, would it not be as easily removed by a power acting in a direction parallel to its sides, as if it were raised in a direct line

with its axis? This will be more clearly understood by fig. 1, where the dotted line represents the tooth as raised from its socket in the direction D. Fig. 3 represents the roots of the large *molare* of the upper jaw, two of the fangs being nearly parallel to each other, while the third is considerably extended. Now, as they are so placed, that what would be perpendicular to one, would be in an opposite direction to the others, it remains to determine what is the best direction to act in for the purpose of extracting it. The dotted line through the centre of the tooth shows the best direction, supposing equal resistance on all sides; but the bone surrounding the root E is very solid, and affords a strong resistance, while it is extremely thin and flexible on the opposite side, and consequently will yield much more easily by inclining the power to that

side acting in the line I F. Although it may be argued, that the Paces may be applied in that direction, it is through admitting the truth of my previous observations, viz. that lateral action is indispensable. But I cannot allow them to be equal, much less superior, to the instrument having a bolster, as, were there no other objection, the circumstance of the Patient being unavoidably made to suffer ten times as long, while the tooth is wriggled to and fro, would be quite sufficient to prevent such a mode of practice from ever becoming general. Nor are the Paces otherwise safe, as they have been known to break away three teeth together, with all that part of the maxillary to which they were attached.

In attempting any improvements in the instruments for extracting teeth, the different means of applying the power (of which there can be but three) should first

be considered ; for, in general, there are but three accessible parts to the tooth, viz. two sides, and the grinding surface. One method is, by grasping, as with the Paces, and, by means of a very powerful arm, wriggling it out of the socket.

The next method is, by means of a bolster wadded, which takes its bearing against the side of the tooth, in the hollow formed by the socket at the part that closes round the neck of the tooth. The third is, by making the purchase, or *point d'appui*, on the grinding surface of the adjoining tooth or teeth. This last method has always been resorted to, as it holds out a temptation to raise the tooth on the principle of the patent cork-screw, though the circumstances of the case are totally different. The cork is taken hold of firmly, by passing a screw through its centre ; but if it were pinched as a tooth

must be at each side, it would have as little chance as the tooth of coming out, without being cut off. But even admitting, in a few solitary instances, the tooth to be strong enough to yield instead of breaking, as the strain upon the adjoining tooth must be precisely equal to the force required to raise the other, it must consequently bruise the periosteum, and it would soon be doomed to share the fate of the one it had assisted in ejecting. If any farther objection can be wanting, it consists in there being no tooth near it; or, what is equally bad,—a circumstance of very frequent occurrence,—the neighbouring teeth being so decayed, or loose, as not to admit of a purchase. It being clear that any attempt to adopt the last of the three methods would be hopeless, and that the Paces are suitable only for single-rooted teeth, stumps that can easily be

laid hold of, and for assisting after the Key has done its part, I may the better proceed to enumerate the advantages of my Instrument over them both.

Description of the New Patent Instrument, &c.

Having shewn in the preceding pages, not merely by argument, but by several illustrations, that the principle upon which the Key acts is, except in a few instances, the only good one for extracting the *molares*, or large double teeth, it will be easy to understand the description of my Patent Forceps, which is so constructed as to form a combination of the principles of the two Instruments now in use, divested of their defects, while their best qualities are greatly improved.

1st. The claw adjusting itself to the size of the tooth, the bolster takes its bearing more correctly than with the Key Instrument, which has only three claws to be used for teeth of all dimensions; the liability therefore of the operator to use a wrong claw will, by this contrivance, be effectually provided against.

2d. A very important advantage in this Instrument is, that it extracts a tooth in *one* operation, as the Instrument still retains its hold when the tooth is loosened, which the Key does not.

3d. The bolster, being made with an adjusting screw, admits of the fulcrum being placed in the most advantageous position, and turning easily, as it does upon a swivel, accommodates itself to suit the external form of the tooth. One of the important advantages it possesses is, that it is a substitute for, and will totally supersede, that

very dangerous instrument called a Punch, for extracting stumps ; it is not only safer, but takes effect with more certainty, and in much less time, and consequently with comparative ease to the Patient.

4th. In cases where the texture of the tooth, from its proximity to the decayed part, is too delicate to allow of its complete removal, a fresh hold can be taken, by slipping the Instrument lower ; and this can be done so instantaneously, as not to be perceived by the Patient.

To medical practitioners in the country, this Instrument will be of the greatest advantage, as it would scarcely be possible, with common attention, to do the injury which may be done by improperly fixing the Key Instrument.

Plates I. and II. shew the Instrument in its most approved forms. Several other variations are introduced into the drawing

accompanying the specification, but I omit them, as giving a decided preference to those herein described.

Figs. 1, 2, 3, Plate II., represent the Instrument for the removal of single-rooted teeth, which is so constructed as to extract them with the smallest possible deviation from the perpendicular action, or in a direction entirely perpendicular, if the operator choose, without the probability of crushing them. It is formed in the handles like the Paces, terminating in a claw, A, on the one side, and on the other at a bolster, B, moving freely on its centre, so as to accommodate itself to the form of the parts where the purchase is made; which centre, being a screw, possesses the advantage of the operator being able to raise and lower the bolster at his pleasure, whereby he is enabled to vary the centre of action to meet the exigencies of the

case. To the bolster arm of the Instrument is attached, by means of a spring, a moveable claw, A, fig. 2, which claw, on simply closing the hand, inclining it at the same time to the bolster side of the Instrument, is, together with the tooth, forced upwards by the inclined plane D.

Fig. 2 represents the tooth when just laid hold of; and fig. 3 its position in the Instrument after the operation.

Fig. 1 is one of the Instruments differently constructed, but having precisely the same effect.

Plate I., fig. 6, is for double teeth only, having a similar adjustment to raise the fulcrum, (*i. e.* the bolster,) by means of the screw passing through its centre, without which no instrument can be complete; this being the most important point in all operations on the teeth, that the purchase, or *point d'appui*, be adapted to the state of

decay, as well as to the situation of the tooth to be extracted. Whatever the size of the tooth may be, the bolster and claw are sure to take their bearing at the part intended by the operator, which result is by no means so certain with the Key, as varying even the thickness of the wadding on the bolster would, without great attention, cause it to take a different position. To use the Instrument, the tooth only requires to be held with a steady hand, inclining to the bolster side till the tooth be loosened, when the hand may be raised perpendicularly without any fear of striking against the opposite teeth and gums. It will be seen, by referring to fig. 4, that the operation is thus performed on the most scientific principles; that so long as force is requisite, that force is applied in the surest and safest manner, and without deviating in the smallest degree from the

best possible direction at that most important part of the operation, detaching the tooth from the socket. The impulse being given in the direction of the tangent line, directly parallel with the line of the opposite side of the root, and the tooth being loosened, it may then be raised in a proper direction upwards, instead of continuing the circular action as with the Key, or making a second operation by detaching it with the Paces.

Figs. 7 and 8 are variations of the same Instrument; one of them, fig. 8, having the claw-arm lengthened, so as to extend beyond the bolster, and fig. 7 having the bolster extending beyond the claw, to be used when requisite, in lieu of SPENCE's and Fox's improvement for the *dens sapientiae*, and others, where the position of the tooth or stump may require it.

Having now completed the description of the various Instruments, I shall merely

observe, that many accidents might be avoided, if every operator on the teeth were to apply himself, exclusively of his anatomical studies, to the attainment of the leading principles of mechanics,* a tolerable acquaintance with this science being essential to success in all the most important branches of the profession. It is absolutely necessary in many cases to be able to invent an Instrument for the extraction of a tooth or stump, which, owing to some peculiarity of form or situation, cannot otherwise be safely laid hold of for the purpose of removing it. I may mention, in illustration of this remark, a case which came under my own treatment, in which

* The term *Mechanic* is frequently misunderstood; a man may be able to use tools of every description, may even file and turn extremely well, and yet be no *mechanic*; while another may surpass him in mechanical genius, without being able to do either the one or the other.

I succeeded in extracting a supernumerary tooth from the roof of the mouth by gradual means, and with comparative ease, which operation would have been attended with considerable hazard of fracturing the palatal bone, if the Instrument *alone* had been used. This was accomplished by means of a ligature.* A bar of gold was fitted correctly between the two first large *molares*, of sufficient thickness to give it a great degree of elasticity, and to prevent injury to the roof of the mouth, by the pressure hereafter described; supports were soldered to it, and fitted to the crowns of the teeth required to assist in the operation, in such a manner that all the power applied would act upon the tooth to be removed without affecting the *molares*. A ligature was then

* This proves how objectionable ligatures must be in fixing artificial teeth.

securely fastened round it, and the other end was attached to an adjusting screw, fixed in such a direction as to give a lateral as well as a perpendicular action, without which, as I have before shown, it could not possibly have been loosened. The screw was tightened daily, when, at the end of a week, the socket was so much enlarged as to admit the use of the Instrument without any risk whatever.

It is of the utmost importance to operate with a light hand, as it not only convinces the patient that he will be saved all unnecessary suffering, but it is by this means that many very serious accidents may be avoided. As a proof how much more may be done by method than by actual force, I shall give one case:—

A Gentleman recently applied to me for the purpose of having an eye-tooth extracted, which had not passed through the

usual place in the gums, but through the thinnest and weakest part of the palatal bone. It had been so injured by excessive violence in stopping it, that it had become absolutely necessary to extract it. This had been attempted by placing the patient on the floor, and although the operator,—a very muscular, powerful man,—exerted his utmost force while the patient was in that position, he could not even loosen it, notwithstanding the point of the tooth being broken off in the attempt. This very tooth, however, I removed, (to the no small gratification and surprise of the sufferer,) with merely a small instrument, no larger than the one I generally use in extracting the shedding teeth. The difficulty of extracting the above tooth did not consist merely in the curved end of the fang, but in its being so situated between and behind the others, as to be almost in-

accessible to any instrument, on account of no more of it penetrating the gum than the part distinguished by the dotted line across the crown of the tooth, Plate I., fig. 9.

In another department, hitherto but little understood, viz., that of correcting irregularities of the teeth, a constant diversity of treatment is requisite. Here, however, little or no improvement has been made upon the rude methods in use, since no rule can possibly be laid down, every individual case requiring a contrivance suited to itself alone. I shall close this first part of the work with an observation of no small importance to those intrusted with the management of children.

Many children are most injudiciously treated, by having nearly the whole of their temporary set of teeth extracted long before the absorption of the roots can

have commenced, or any symptoms have appeared of the new teeth penetrating the gums. This point cannot be too seriously attended to, as will be evident when we consider that, independently of the cruelty of inflicting needless sufferings upon a child, some teeth of the first set are frequently of the utmost service in compelling the new ones to range themselves in a more extended circle. The consequence of not attending to this circumstance may force upon us the necessity of being obliged to extract some of the new set also, to give room to the others, or the deformity will be as great, or perhaps greater, than if they had been totally neglected.

PART II.

A

DESCRIPTION

OF THE

NEW PATENT METHOD OF FIXING

ARTIFICIAL TEETH.



A

DESCRIPTION,

&c. &c.

I SHALL now offer some observations upon the use of artificial teeth, previously to describing the new method of fixing them, for the invention of which I have obtained a part of the double patent before referred to.

For the introduction of artificial teeth we are indebted to our very ingenious neighbours the French. Whether the French derived the invention from others, or whether the art originated with themselves, is a question not so easily decided. To examine the records of ancient times for the history of this ingenious and very important art would be almost as useless as to

search for the rudiments of a complete system of political economy in the sententious and ambiguous responses of the ancient oracles, or for the prognostication of future events in the garbage of a brute, or the flight of a bird. We have indeed the expression in Martial, “*Dentata sibi videtur Ægle, emptis ossibus,*” in which the “*emptis ossibus*” would lead us to conclude, that artificial teeth of some kind were then used. Rude enough we may naturally suppose them to have been, both from the infant state of the mechanical sciences at that time, and also from the pointed irony of the satirist, in the words, “*videtur sibi.*”*

* The Roman ladies were extremely careful of their teeth, most of whom washed them with water. Some, however, used a composition which came from Spain. They cleaned them with small brushes and tooth-picks, some of which were of silver, though those of the wood of the lentisk were considered the best. The same Poet expressly informs us, that they had

That the Romans were not inattentive to personal appearance, we have many proofs which might be adduced,* and we may readily believe that a good set of teeth would, among other things, have occupied some share of their attention. This, however, is a question more curious than important, since every thing which relates to the case, in a practical point of view, is as much within our reach as though we had been intimately acquainted with the art among ancient nations. The importance

artificial teeth. In an epigram, he advises Maximina never to laugh: "Thou hast only three teeth," says he, "and these are of box, varnished over. Thou shouldst fear to laugh. Take an air more severe than the wife of Priam, or the eldest of his fair daughters. Shun the postures and jests of Philistian, and all that may give occasion to open the mouth."

* It is said, that when a laurel coronet was adjudged to Julius Cæsar for his military exploits, he was pleased with it less as an emblem of victory, than as a cover for the baldness of his scalp.

of the subject renders it worthy of whatever observations may tend to illustrate it; and I must here observe, that the remarks which I have before made upon the necessity of paying immediate attention to a decayed tooth, for the purpose of preserving the set, will apply with additional force under this part of my subject. Whatever the advantages may be in having a carious and dangerous tooth extracted, they must be two-fold in having the lost teeth renewed. In the former part of this pamphlet I have mentioned the importance of the proper preservation of the teeth for three distinct purposes, viz.,

1. Mastication of food :
2. Articulation :
3. Personal appearance.

In my previous observations, I have spoken at some length upon the first of these points only, reserving the two last for

notice in the remaining part of the work. I have made this distinction rather in compliance with popular feeling, than on account of the nature of the case; because not less for articulation and appearance, than for mastication, ought every person to make the preservation of the natural teeth an object of the greatest care; nor less for mastication than articulation and appearance ought the same care to be employed in the restoration of the teeth when lost. But the fact is, that as the importance of perfect enunciation, as far as it is dependant upon the teeth, is seldom felt till the loss of the natural teeth have destroyed it, and more especially as the idea of personal appearance, as far as the teeth are concerned, is so much more closely allied in the mind to artificial than natural teeth, on account of the generally defective state of the former, and the very high perfection to which the

latter have attained, I have purposely reserved these two particulars for some remarks under the second part of this work.

Upon the first of these points it would be absurd here to do any thing more than merely to remind the reader of the very great detriment incurred in articulation by the loss of the teeth or palate. In addition to a feeling of something bordering upon contempt excited in the hearer by a lisping enunciation, the effect of speaking, whether in private or public, is by this circumstance so visibly diminished, that perhaps no deficiency or deformity of person, so much as this, incapacitates any individual for giving full effect to his ideas, or for enjoying the pleasure of making a due impression on those whom he addresses. Still less need be said upon the state of the teeth in reference to the

second point, viz. personal appearance. Every one must be conscious that a defective or injured set of teeth is almost the very worst recommendation, as it regards personal appearance, of which we can conceive. The use of artificial teeth by so many illustrious individuals in the higher ranks of life, by eminent members of the professions, as well as by the great body of the public, is sufficient evidence of the estimation in which they are held. Here then we may fairly congratulate ourselves that by the very high state of the improvement of this art in our own country, such facilities are given to the accomplishment of an object of so much importance. Upon this topic I am sure that those, who may have any intention of renewing their lost teeth, will feel no small interest in the description which I am now about to give of my improvements for supplying the deficiencies of

nature or accident by artificial means, and in the subsequent observations connected with this subject, with which I shall close this short work.

I have before observed, that for the introduction of artificial teeth, we are indebted to the ingenuity of our neighbours the French. Until very lately, they were believed to be the only persons capable of properly executing any thing appertaining to the science of a Dentist. Such, however, has been the rapid improvement of the art in this country, within the last few years, that numbers of English residents in the French metropolis (I speak from experience) visit London, for the purpose of availing themselves of the skill of English Dentists in the fixing of artificial teeth: notwithstanding, this branch of science has by no means attained perfection, as to general practice, among us.

Having, from the commencement of my professional avocations, paid the most particular attention to this art, and sedulously studied every means of raising it to a higher degree of perfection, I think I may with more confidence offer some observations on the deficiency of the methods hitherto practised, and on (as I confidently anticipate) an improved method, of my own invention, before referred to.

I shall first speak of the method of *pivottting* teeth.

This method, though oftentimes indispensable, is so simple, and requires so little ingenuity, as to be frequently adopted in cases that ought by no means to be supported by pivottting, and for which far preferable means might be devised. It consists in merely piercing a hole in the stump of a tooth, and grafting the crown of another natural tooth upon it, by means of

a pivot fixed into it. This would be far preferable to any other method for neatness, were it not for the impossibility of removing them (without rendering them insecure) for the purposes of cleanliness—a circumstance of vital importance to those who wear artificial teeth, consequently it ought studiously to be avoided, when any other means can be adopted.

Another method is, by mounting as many teeth as are deficient, either upon a base made of the tooth of the hippopotamus, or of any hard animal substance, or on a plate of gold,* silver, or platina, making holes at each end, and tying them round the adjoining teeth. But this method is liable to many objections.

* The use of gold should by all means be preferred before any other substance whatever, as it is so much stronger, and more favourable to cleanliness; it is also rectified with more facility when deranged, and occupies much less space in the mouth.

In the first place, if it be tied on both sides, and there be any space between the piece and the two teeth supporting it, the strain upon them is so great as to loosen them in a few days, or weeks at farthest. The consequence of this is, that they fall out many years sooner than they otherwise would have done.

Another serious injury occasioned by the ligature, unless it be renewed daily, (which is both troublesome and very difficult when tied to the back teeth,) is, that it absorbs and retains the juices of the food. This in a short time becomes not only foetid, but so corrosive as to penetrate the body of the tooth, and to bring a sound one to decay almost as rapidly as if it had been disposed to caries. A gold wire will indeed obviate this evil, but it has the disadvantage of not being removable at pleasure.

We come now to a third method, (certainly far preferable to the two described,) by which the teeth are mounted in a similar manner to the former, but instead of holes being made for ligatures, a spring, of either round or flat wire, (see Plate III, fig. 10,) is soldered, or otherwise fixed to the gold plate, and made to fasten round the adjoining teeth. This answers extremely well in many cases, but it is still liable to serious objections. One of the most obvious of these is, that in a free and natural laugh, when the lips deviate so far from their ordinary compression as to discover the necks of the teeth, the glare of the fastenings in a moment attracts the eye and ensures detection. Many, probably, unconscious of the exposure, thus lose one of the great advantages, and perhaps the only one in their estimation, of artificial

teeth, viz. the admiration of the beholder in the belief of their being natural.

Another disadvantage of this method is, that, being laterally supported by the adjoining front teeth only, (the springs being unavoidably very slight for the purpose of concealment, as well as to give them greater elasticity,) they have too little strength to bear the force to which they are sometimes subjected, however careful the wearer may be. They are liable also to become very loose, and in many instances they cannot be well secured, by reason of the teeth on which they are supported being so much smaller at the neck, viz. the part next the gum, that the spring, in going over the bulkier part of the crown of the tooth, is strained open so far, that it cannot possibly close again so as to cling round the tooth intended to be used as a support to the artificial ones.

In introducing the preceding observations and objections, I do not intend to pass an unlimited censure upon any of the methods in question, but to shew that my plan is far preferable for the preservation of the remaining teeth, the security of the fastenings, and for avoiding needless operations.

I now come to mention the principle of my own invention, which consists in *carrying the fastenings of artificial teeth to the hinder parts of the jaw, and fixing them upon the strong-rooted double teeth.*

For the purpose of obtaining the full advantages of the art in cases where only some of the front teeth are deficient, instead of fixing them upon the usual principle, with wire springs to pass round the adjoining teeth, as represented at fig. 10, I continue my gold towards the back ones, only so far as may be sufficient to fix it

where the supports will be concealed, choosing those teeth for the purpose that are best calculated to hold them. Whenever it may be found practicable, the first large *molare* for a firm hold, either for the upper or lower jaw, is decidedly preferable. Those referred to at figs. 5 and 6 are extreme cases, which being obstructed by the lower teeth, could not otherwise have allowed of the operation. Where there is a separation between any of the double teeth, it is easily seen that the springs can pass between to go round, or partly round, the tooth; but where no such facility exists, the fastening is to be accomplished by means of a spring, represented at fig. 1, which, as it passes across the teeth, (see A, fig. 2,) for distinction, I term a *saddle-formed spring*, which spring, if well proportioned so as to yield equally, has the advantage of holding with greater

security, and is less likely to be deranged by the wearer in removing it, than a spring upon any of the former methods, which frequently are clumsy without possessing any elasticity.

To avoid repetition in the engravings, each figure represents two methods, it being by no means always necessary for the support of two front teeth, as there shewn, to fix them on both sides of the mouth. It is requisite only to imagine the arm extending to the tooth on the right side as cut off, and it will represent a case of two teeth held up by the left side, and the contrary for the opposite side. Each of them is represented by a different kind of fastening.

In other cases, where the teeth are usually supported partly by wire springs on the front tooth or teeth, and partly with the assistance of the nearest back tooth, I am enabled, in every case whatever, to support

them equally well without the spring on the front tooth, by adopting the saddle-spring before described, which usually requires no other support, if due attention be paid to the work it has to perform, though sometimes it demands the additional aid of the double spring, which I first contrived for a case that had baffled every attempt without the ligature.

The double spring, shewn in a side view at fig. 3, is a very great improvement upon the single ones, which are usually made of only flat gold, without any regard to mechanical proportions, and which consequently lose the greater part of the strength they might otherwise have possessed, and are at the best frequently very deficient in elasticity, upon which the action of a spring depends.

It often happens that a *molare* is considerably smaller at the neck than at

the grinding surface, in which case an ordinary spring, however well it may be constructed, has not sufficient elasticity to close round the tooth, without its being made so slight as to defeat the design of it, viz. the supporting the artificial ones securely, without fastening them to the front teeth; but by fixing one spring on the surface of the other, each of them being duly proportioned, a considerable increase of strength may be obtained, while a much smaller degree of force is sufficient to take it out and replace it.

The saddle-spring, (some of which are also double, see B, fig. 4,) is extremely useful where the only remaining teeth in the mouth are two or three double ones on one side, without there being any teeth opposite for fastenings. I have also contrived another very excellent spring, which may be used in aid of the two preceding ones, con-

structed either of flat gold or of wire, which, instead of being open, should be made slighter, and soldered together at the two ends, making an entire elastic ring. This kind of spring will sometimes be of great service, when neither of the others would answer the purpose; from which it will be readily perceived, that success depends as much on the proper application as on the invention of the above methods.

Fig. 7 is an end view of fig. 5, and fig. 4 is a side view of fig. 9. The dotted lines in each figure surrounding the front teeth, shew how the cases would have been treated in the ordinary way.

I shall now, having described the improved method of fixing teeth, advance a few general observations, which I think will be neither uninteresting nor useless to those more immediately concerned.

A most important point to be consi-

dered in constructing artificial teeth is, that the adjoining ones shall receive no injury. The perfection of teeth, artificially placed, does not consist in their merely looking well, or being perfectly easy and comfortable, though these are indispensable requisites: I have met with frequent instances where teeth have been highly eulogised merely because they had a good appearance, although in a very short time they loosened their supports, and must ultimately have entirely removed them, had they been worn much longer. I may, however, just observe, that the methods which I have adopted have completely obviated this most important objection, and I have invariably had the satisfaction of seeing the teeth, in a very short space of time, become perfectly firm in their sockets.

There are numerous adjustments and contrivances requisite in fixing artificial

teeth which cannot be explained, and can only be acquired by long and extensive practice. The work done by assistants embraces but a small portion of the skill displayed in the construction of teeth, and would avail but little, unless it were directed by the judgment of the person who examines the mouth, and who has a much more difficult task to perform in the final adjustment of them.

By the fastenings being made to the back teeth, the teeth to be fixed are infinitely more secure, the hold being by this method transferred from single-rooted to two and three-fanged teeth. In the first case, their hold is slight, and of course temporary; in the last it is firm and permanent.

This method is also particularly advantageous where the adjoining teeth are weak, and consequently exposed to injury by fastenings; for even if those teeth, in the

course of nature, give way, the fixtures, not depending upon them in the smallest degree for support, as they otherwise must have done, the artificial piece is not thereby rendered unserviceable. One of the greatest proofs of the artist's skill consists in securing them, if possible; so that when one support fails, the rest may be available, a matter of no inconsiderable importance to persons residing in the country, or who are in the frequent practice of quitting London, not only as it regards comfort but economy.

Many are prevented from having the loss of teeth supplied, by an idea of the necessity of the intervening teeth and stumps being removed; and in numerous instances are persuaded, in an unlucky moment, to submit to the extraction of a sound tooth, which, with good management, would have proved of the utmost

service in support of the artificial ones. Independently of the additional expense occasioned by increasing the defect, this objection, it will be immediately seen, will be completely obviated by the improved method of constructing the fastenings.

I must not forget to observe, that in the formation of springs for artificial teeth and palates, (to which these different contrivances are equally applicable,) there are two very important points that in many instances are not sufficiently attended to.

Considerable advantages, in the degree of elasticity, are to be obtained by attending to the formation of a spring, particularly its thickness and its mechanical proportions in different parts, always remembering to suit it to the duty it may have to perform. It was while making experiments on springs of different forms and proportions, that I found that two

slight ones, (where they could be applied,) sliding freely upon each other, would hold firmly, where those constructed in the usual manner were totally useless. The gold, of which they are made, should be in its texture as close and as hard as possible, and of a superior quality, requisites that are too frequently dispensed with ; for, in many instances, persons, forgetting that a low price is not necessarily a cheap one, are deceived, and oftentimes seriously injured, by artifices to which a respectable practitioner would not have recourse.

Platina is very generally used by the French Dentists, on account of the difference in the expense between that metal and gold being so considerable. But it is totally unfit for the purpose, being so ductile, that in a series of experiments, to ascertain what degree of elasticity could

be given to it, I drew an ingot of platina, half an inch in thickness, to the smallest size used for springs, without annealing it, but did not obtain any elasticity whatever; the only difference so much hammering and drawing had made in its texture being the appearance of a number of very minute flaws on attempting to bend it.

The use of gold and silver in actual contact with each other is another evil that can and ought to be guarded against, although the injurious effect may be rarely felt, and even then only by persons of extraordinary susceptibility. The consequence of the union of the two metals, where it is experienced, is a most disagreeable and continued taste of the baser metals, such as brass or copper, although there may not be a particle of either of these in the gold or silver. The fact is, the effect is purely *galvanic*.

The following very remarkable instance led to the discovery of this circumstance, by which I have since been enabled to apply a remedy to two others, who were afflicted in the same manner.

A Lady having had several artificial teeth mounted upon gold, which she had worn nearly four years, had occasion to get one of the rivets renewed, at a part which came almost perpetually in contact with the tongue. From that moment she was greatly annoyed with a most disagreeable taste, as before stated. This was so extremely unpleasant, that she consulted several very eminent practitioners without obtaining the smallest relief. On examining the gold, I found it too good to be acted upon by the usual tests; and the silver screw with which it had been repaired was equally pure. Consequently, as it could not arise from the base alloy of either of the metals,

I thought it might very probably be traced to the effect of Galvanism, and soon ascertained my conjecture to be well founded. The experiment which I made was this : I covered the exposed surface of the silver rivet with gum lac, after which the evil was most effectually removed.

Having so far succeeded, in order to satisfy myself that the silver was not in fault more than the gold, I scraped off the gum lac, and completely covered the surface of the gold with the gum, when, as I expected, the result was precisely the same, the relief being equally effectual. The evil returned as before on clearing away the gum. Having now ascertained, beyond a doubt, that I had discovered the true cause of this unpleasant sensation in the mouth, I substituted a gold screw for the silver one, since which, not the slightest symptoms of the evil have ever been perceived. The

two other cases before referred to being precisely similar, it would be mere repetition to describe them.

I have now merely to conclude with the expression of my sincere wish that the arts of extracting and fixing teeth, so important,—whether we consider them in reference to the health or convenience of so large a portion of the community,—may derive from these two Inventions, to which I have now given publicity, that accession of improvement which my past experience amply justifies me in expecting. Indeed I am confident, that a proper understanding of the description I have given of my methods of operating will ensure a trial, and I am equally certain that a trial will ensure approval.

THE END.

Fig. 6.

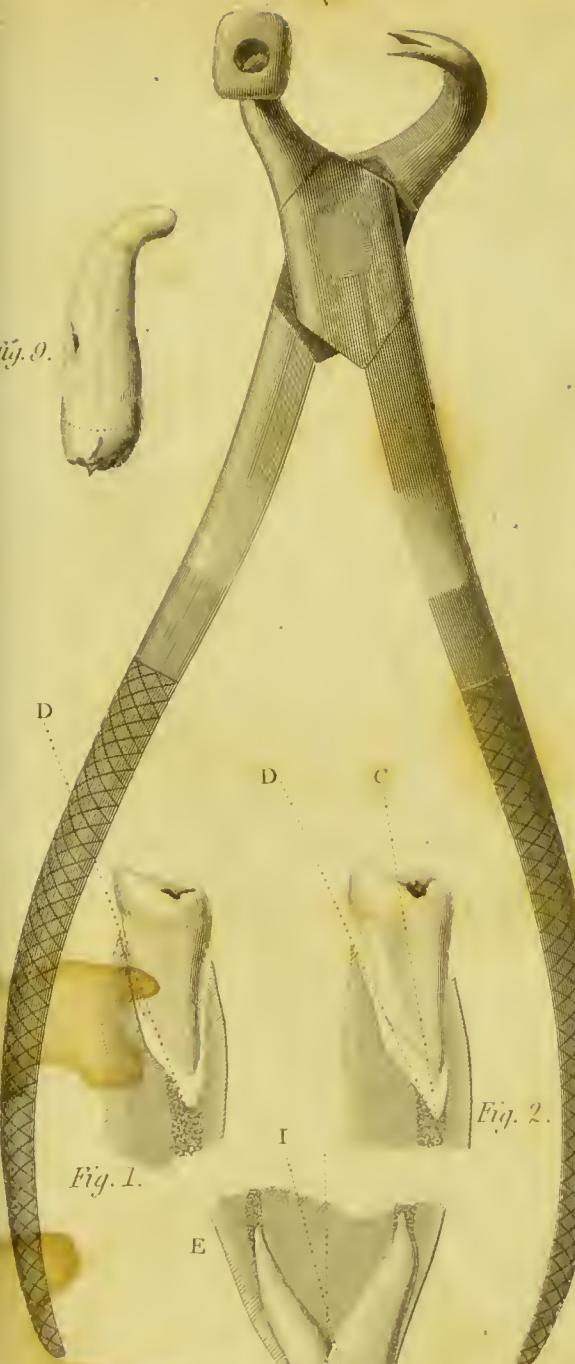


Fig. 1.



Fig. 3.

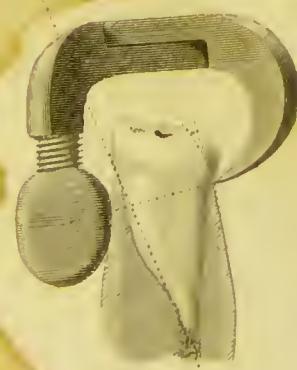


Fig. 4.

Fig. 7.

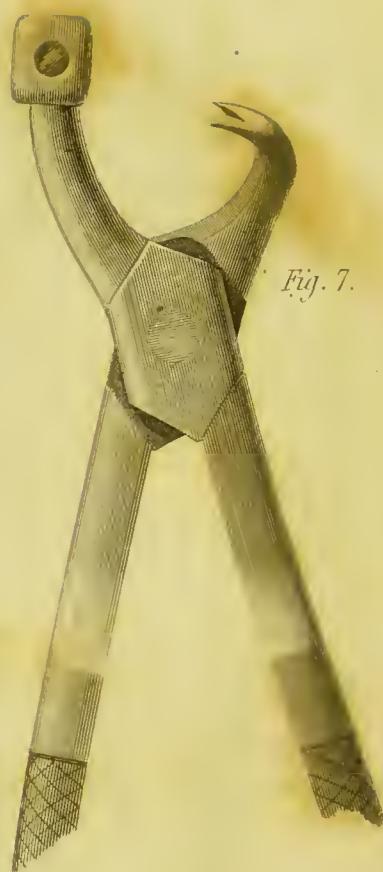


Fig. 2.



Fig. 5.

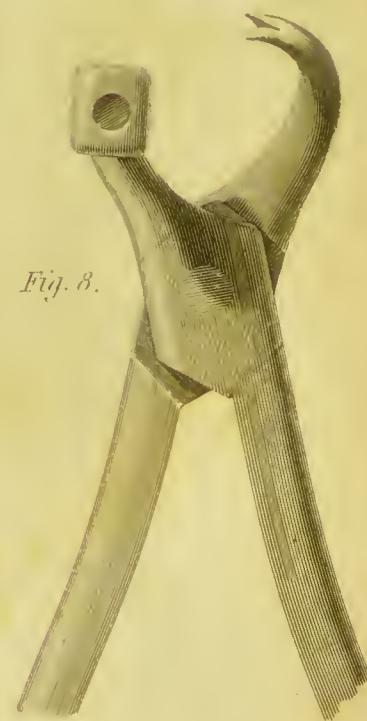


Fig. 8.

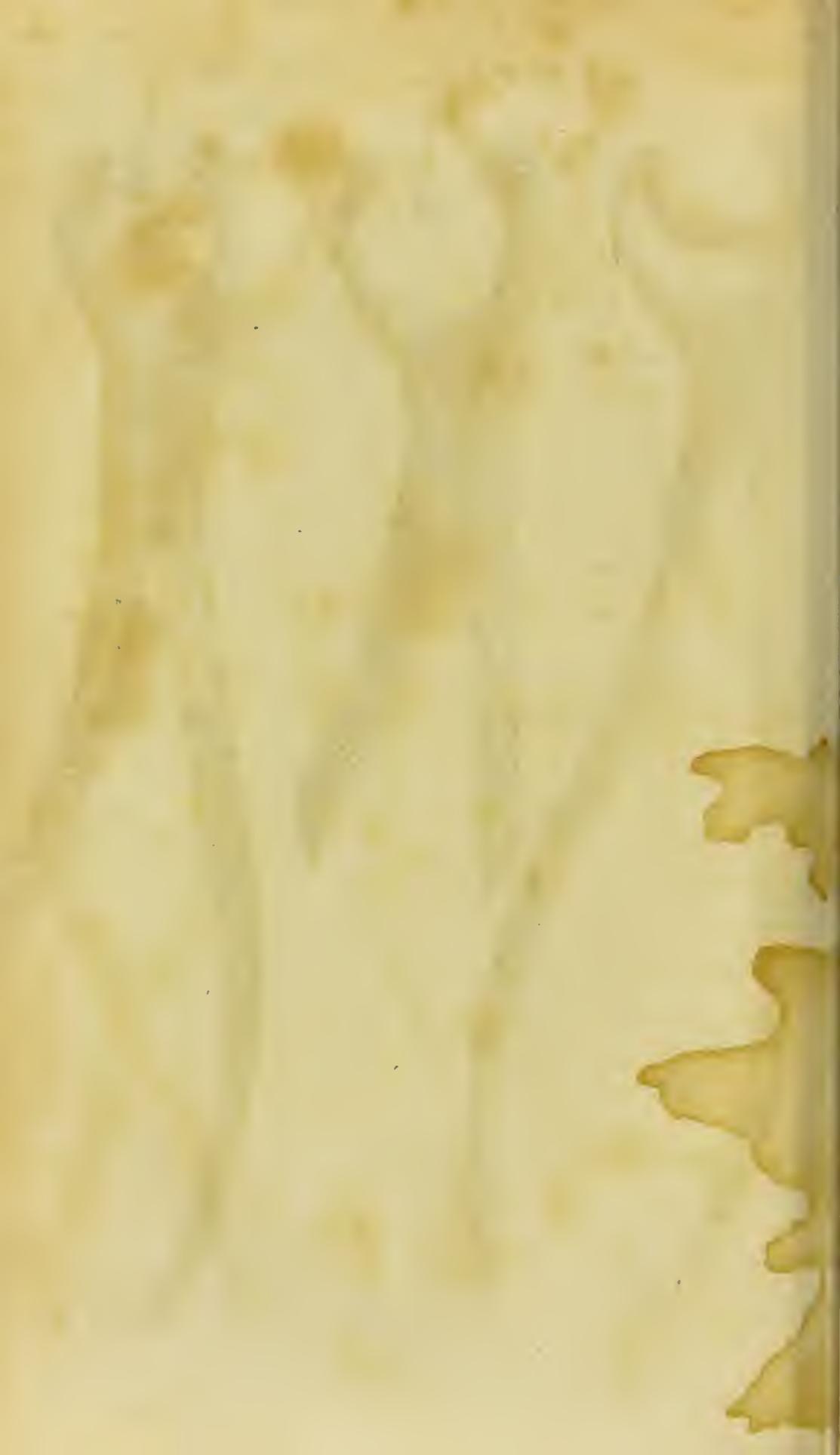


Fig. 1.

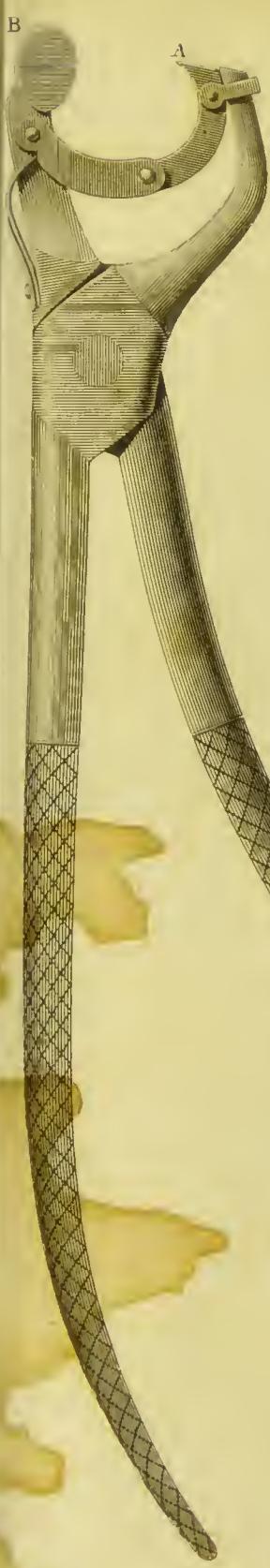


Fig. 2.

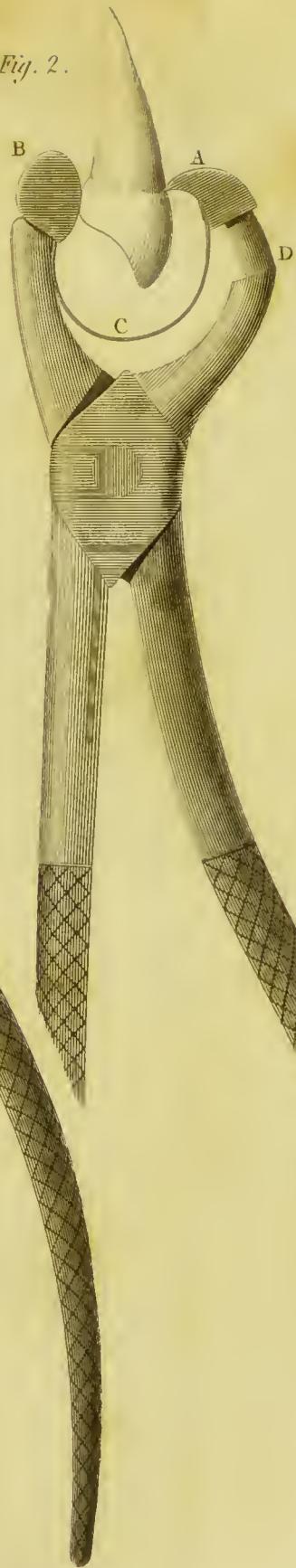


Fig. 3.





